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DIGITAL HUMANITIES | RESEARCH ARTICLE

Digital finance as a mechanism for extending the boundaries of financial inclusion in sub-Saharan Africa: A general methods of moments approach

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Abstract: To address the Sustainable Development Goals of poverty eradication, hunger elimination, unemployment and inequality reduction, it is pertinent to pursue a sustainable all-inclusive financial growth that will be delivered on digital financial platforms. With the revolution in the financial technology space occasioned by competition among financial market intermediaries, there is no doubt that more unbanked and under-banked citizens will be captured into the formal financial net of the economy. This study investigated the dynamic causality amid digital finance and financial inclusion using ten years (2007–2017) secondary data obtained from the World Bank data base in 27 sub-Saharan African countries. The analysis was done using Granger Error Correction Method (ECM) with General Methods of Moments (GMM). The result showed a positive long-run correlation between digital finance and financial inclusion. Thus, for the overall sample the ECM coefficient (−0.30) has probability value of 0%. It therefore recommends amongst others that monetary authorities of emerging and developing economies in sub-

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PUBLIC INTEREST STATEMENT

There is evidence from literature that financial technology has the capacity to break all known barriers towards delivering financial products and services that will meet the needs of indigent persons in rural communities at affordable cost and in a sustainable manner. Bringing individuals into mainstream finance using digital platform will enable them build capacity, obtain skills and access to finance that will engender wealth creation, reduce poverty as well as eliminate unemployment and inequality in the community which they belong. It is on this premise that this study seeks to examine how financial innovation through digital inclusion will drive financial inclusive growth and by extension achieve Social Development Goals of hunger elimination, poverty reduction and employment creation amongst 27 SSA countries

Sahara African countries should embrace digital financial technologies by encouraging commercial banks to install more ATMs and discourage acceptance of cash payment and withdrawals within established thresholds across bank counters in their respective countries.

Subjects: Computer Science;; General; Development Studies; Sustainable Development; Development Theory; Economics and Development; Economics; Finance; Business, Management and Accounting

Keywords: Financial inclusion; digital finance; financial intermediation; poverty reduction

Subjects: G21; G23; L26; I24

1. Introduction

Most countries the world over adopted financial inclusion and entrepreneurial development as veritable tools towards achieving the Sustainable Development Goals of 1, 2 and 8 denoting poverty reduction, hunger elimination and wealth and employment creation. It is in this light that the G20 Leaders and some international financial institutions made a commitment to adopt financial inclusion as building block for economic growth and rural development (G20 Leaders Communique, 2012). Development finance literature is awash with studies establishing the link between financial innovation and real sector growth. Prominent among these studies are the works of Ozili (2018), Vo and McAleer (2019), and Ngongang (2015) which support that financial innovation is key to inclusive financial and real sector growth. Overtime, the financial sector in most African economies have transformed from just providing access to credit for the poor, to rural banking, community banking and more recently to micro financing, financial inclusion and wellness. All these strategies are aimed at ensuring that the active poor in rural communities have access to the needed finance for productive ventures. Investment in financial or real asset by these segment of the society will help them to engage in sustainable economic activities that will engender food and financial security. Such economic activities may include palm oil processing, animal husbandry, barbing and hair dressing salon, rice milling, cashew processing, IT services etc. When indigent citizens are financially empowered, they can provide for themselves and families, pay for their children education and hospital expenses, save for retirement and social security, as well as weather economic shocks as they arise. The Consultative Group to Assist the Poor report for 2016 reveal that a more inclusive financial system is fundamental in the process of creating a more inclusive, equal and peaceful society. Four major challenges hindering the effective and seamless delivery of sustainable financial facilities to the rural poor in sub-Saharan Africa (SSA) includes: (i) small size of most African economies which limits demand and expansion of such products, (ii) uneven geographical distribution of the population makes the service points too far for them therefore necessitating their use of informal financial platforms, (iii) thirdly they are perceived as high-risk customers due to the volatility of their income streams and (iv) governance and regulatory issues hinders participation of non-banking institutions that will trigger healthy competition (Beck et al., 2007; CGAP, 2016).

Technology has disrupted the work process almost in every sector of the economy. The revolution for an economy driven wholly on technology has been made more formidable with the outbreak of COVID 19 pandemic still ravaging the world. The new normal way of life occasioned by the economic lockdown will bring to the fore new economic powers, new technologies and new operational standards which will shape global economy (Sing, 2016). Companies and institutions are gradually devising means of adapting to the current trend of working from home and social distancing and financial institutions are not exempted. Intermediation through financial technology is gradually dominating conventional or traditional financial intermediation. Research has shown that financial inclusion driven on digital technological platforms has the potentials to break necessary barriers and improve performance and efficiency of both the provider and user of such financial product and services. Despite significant progress recorded by some sub-Saharan African countries in digital financial inclusion, the report of International Telecommunication Union

(ITU) (2016) as cited in Ozili (2018) shows that most developing countries still face considerable challenges in digital technology in business transactions. The global financial and stability report of the World Bank reveal that emerging markets are encumbered with retarded growth, weaker commodity prices and stringent credit requirements amidst more unstable portfolio flow (World Bank Group, 2016). In view of the above identified challenges, this study examines how barriers towards formal inclusion of the unbanked can be eliminated using digital payment platforms.

2. Theoretical and empirical literature review

This study is hinged on "The Reasoned Action Theory by Fishbein and Ajzen (1975) and Technology Acceptance Model as propounded by Davis (1986) as cited in Okoye et al. (2019). These studies argue that the main reason firms and individuals accept new technology is because of its apparent usefulness and user friendliness. Also a piece of equipment is user friendly when with little or no effort the equipment is seamlessly applied to work and deliver results. When such innovation is used continuously, value is created and as a consequence the user becomes satisfied and contended using the item going forward. The justification for its adoption stem from the fact that when financial inclusion is driven on digital technology platform (mobile/telecommunication networks) it has the potential to capture the unbanked or underbanked poor in rural communities into the formal financial net. Acceptance of such products or services will make the users repose trust and confidence and accept more products introduced by the financial institution thereby deepening financial and economic growth. The end result is that the poor will be able to create wealth for themselves and families and are lifted out from extreme poverty. This theory does not consider the fact that innovations and development in certain sectors may make some equipment that initially were user friendly to be obsolete and therefore not able to add value anymore. Examples are common with technological devices or equipment which are transformed from one generation to another or from one model to another.

Ratna et al. (2015) posit that more than half of the poorest 40% of citizens in developing economies are without formal accounts whereas 35% of start-up companies have troubles accessing credit from the formal financial institutions. Also large gaps in access to formal financial products exists between the rich and poor in the rural and urban communities as well as between women and men Ratna et al. (2015). These studies show that gaps still exist in SSA despite efforts at promoting financial deepening and financial inclusive growth. This is also worrisome as Africa ranks below other developing countries with only 23% of the adult population owning an account in a formal financial institution. This percentage is far below the acceptable global threshold of 50% Dabla-Norris et al. (2015) and Demirgu¨ç-Kunt and Klapper (2013) as cited in Ajide (2017). Figure 1 below, demonstrates how government/private sector partnership can drive inclusive and real sector growth as well as reduce poverty. The dividend will yield faster when the financial products and services are delivered on digital platforms with its capacity to reduce cost and save time as well as eliminate all known barriers.

With an increasing demand for an all-inclusive financial security and economic growth by almost all sovereign nations by 2030 there is an urgent need to eliminate the widening gap between the rich elites that are financially included and the poor that lack financial services especially in rural communities. According to Agarwal (2010), the active poor and down trodden in rural communities who are the growth engine of every economy should benefit more from using formal financial product than anyone else. In a study conducted in Kenya by Jack and Suri (2014) the findings shows that households that used M-PESA platforms has greater capacity to withstand economic shocks and cater for unexpected expenses than their counterparts who do not use it. Honohan and King (2012) opined that highly educated and financial literate persons are more financial technology savvy individual, they understand the rudiments and processes of digital financial services and therefore repose higher trust in them than the uneducated rural dwellers. This study did not consider the impact of craftsmanship/apprenticeship on the use of certain technology because not all educated persons knows how to use ATMs and also uneducated persons who use these devices regularly master the art than the financially literate and educated customers. Demombynes and Thegeya

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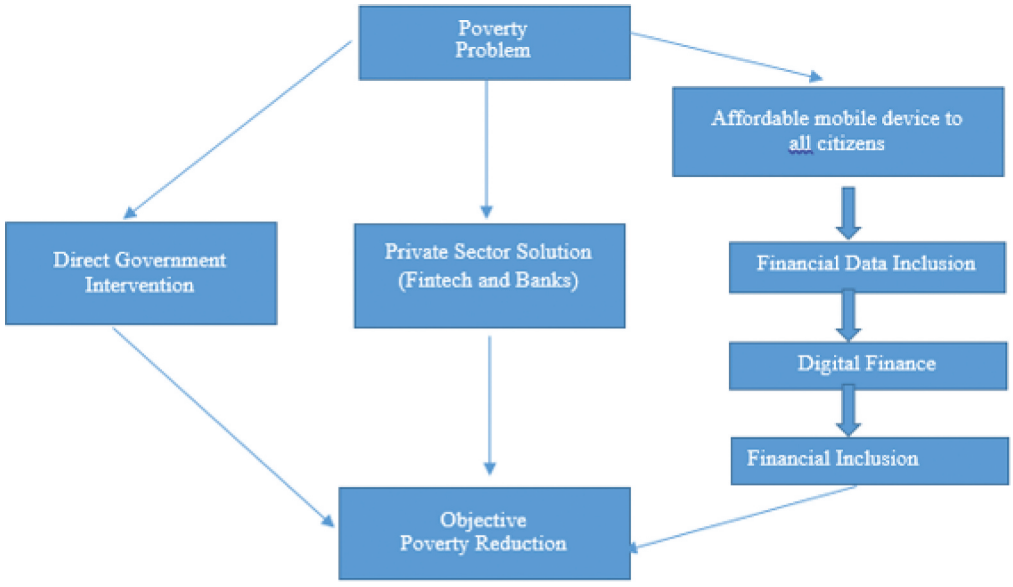

Figure 1. Government/Private Sector Partnership to Drive Digital Financial Inclusion.

Source: (Ozili, 2018).

(2012) study confirmed that the wealthy groups in Kenya were more disposed to using integrated mobile savings products than the rural poor. Also that men are more likely to save than women and that a bulk of the population make use of mobile phones for financial transaction especially amongst those who are unlikely to save using formal channels. Oumaa et al. (2017) investigated whether the universal use of mobile telephony to deliver commercial services is a benefit for savings deployment in designated nations in sub Saharan Africa. The study revealed that households who used mobile phones to deliver financial services are more likely to save than those who used manual means of delivering financial services.

Koppensteiner and Olukorede (2016) investigated the effect of mobile money adoption by households in Tanzania on consumption smoothing, poverty and human capital investments. The results shows that while per-capita total spending is not levelled within recommended specifications, per-capita expenditure pattern for the very poor families is significantly levelled in era of adverse idiosyncratic shocks for families that used mobile money. The study indicate that household that used mobile money conveniently shield against sliding into transient extreme poverty while there is an increase in head count living below US$1.25 per day for non-adopter households. Isibor et al. (2018) examined the impact of electronic banking on banks' performance, customers' fulfilment and economic growth and found that electronic banking has enhanced both clients' contentment and economic growth in Nigeria. Forgelli and Rubino (2016) investigated how mobile banking can increase finncial inclusion as well as improve the welfare and wealth of individuals in developing countries. It found a slightly positive relationship amid mobile banking and inclusive finance inclusions. In like manner. Achugamonu et al. (2016) conducted a study on the relationship between agent banking and financial inclusion in Nigeria. The study revealed that high level of illiteracy among the unbanked populace constitute a major barrier to achieving high financial inclusive growth in Nigeria. Amoo (2018) posit that SSA ranked behind other regions in terms of developmental strides especially using some millennium development goals indicators like better public health, maternal death rate reduction, and poverty and hunger elimination. SDGs are goals designed to address basic issues of poverty, healthy and environmental friendly society and maternal mortality. The purpose is to eradicate poverty, preserve the planet and ensure that citizens enjoy prosperous, harmonious and peaceful co-existence now in the future, (Morton et al., 2017).

3. Materials and methods

This study used purposive sampling technique to collect data from World Bank database. Out of the 46 countries located in sub Saharan Africa region between 2007 and 2017 only 27 countries were selected because they possess the data needed for this study. The period covers the pre and post global financial meltdown experienced between 2008 and 2010 (Sanusi, 2010). The ethical standard put forward in obtaining the data include disclosing the website where data was obtained which is as well as using the data without manipulation and given credit to World Bank, organisation reputed for providing financial data for the purpose of research. The study relied on World Bank data because of the integrity, transparency and robustness of their research output overtime. The sample size therefore accounts for 59% of the total population. This study adopted a Granger Error Correction Method (ECM) specification for a short panel data structure. To deal with the problem of persistency, heterogeneity and endogeneity associated with short panel data the study employed differenced Generalize Methods of Moments (GMM) of Arellano and Bond (1991) for the model specification. The estimator is subjected to first and second order serial correlation test and test for valid instruments using Sargan over identifying restriction test. Therefore, the nature of our panel data is such that the individual dimension is larger than the time dimension ($N > T$). The justification for adopting this methodology is because of the nature of data involved (which is short panel data).

3.1. Variables definition and sample identifier

There is no doubt that access to financial products and services is the first point of financial inclusion, but not everyone that owns an account actually uses them. This study takes the debate further by introducing actual usage and quality of financial products/services as variables for financial inclusion (Global Financial Development Report, 2014/2016 and Forgelli and Rubino, 2016). Actual usage in this context is measured by the number of tangible deposits in commercial banks for every 1000 adults denoted by (dcpa) whereas quality of financial service offered is measured by the proportion of depositors compared to borrowers. It is expected that a bank will have the capacity to extend more credit when the amount deposited is more than loanable fund in the financial system. While digital finance is represented by percentage of persons using ATM (ppua). The justification for using the variables mentioned is based on the recommendation of the World Bank of the choice of these variables as ideal for measuring financial inclusion and digital finance. Also see Chibba (2009) and Cihak et al. (2016). The 27 countries are identified by allocating numbers to the them in descending order according to alphabetical arrangement. For instance, Zambia is number 27, Uganda is 26, Tanzania is 25, Seychelles is 24, South Africa 23, Rwanda 22, Nigeria 21, Namibia 20, Malawi 19, Mauritius 18, Mauritania 17, Mozambique 16, Madagascar 15, Lesotho 14, Liberia 13, Kenya 12, Gambia 11, Guinea 10, Ghana 9, Equatorial Guinea 8, Congo, Republic 7, Congo Democratic Republic 6, Cameroon 5, Central African Republic 4, Botswana 3, Burundi is 2 and Angola 1 (Achugamonu et al., 2020).

3.2. Model specification

According to Chibba (2009) and Cihak et al. (2016), ECM-ARDL Granger framework is adopted to initiate a dynamic short run and long run specification for the model. Thus, this augmented model is defined by financial inclusion as the dependent variable {represented by deposits in the commercial bank per 1000 adults (dcpa), and ratio of depositors to borrowers (rdtb)} and digital finance as the independent variable {also proxy by percentage of persons using ATM (ppua)}

$$lndcpa_{it} = f_0 + f_1 lndcpa_{i,t-1} + f_2 lndcpa_{i,t-2} + f_3 lnppua_{it} + f_4 lnppua_{i,t-1} + f_5 lnppua_{i,t-2} + \varphi_{t1} + V_{it1}. \quad (1.0)$$

$$lnrdtb_{it} = g_0 + g_1 lnrdtb_{i,t-1} + g_2 lnrdtb_{i,t-2} + g_3 lnppua_{it} + g_4 lnppua_{i,t-1} + g_5 lnppua_{i,t-2} + \varphi_{t2} + V_{it2}. \quad (2.0)$$

Where: $\ln ppui$, $\ln dcpa$, *and* $\ln rdtb$ are natural log of percentage of persons using ATM, deposit in commercial banks per 1000 adults, and ratio of depositors to borrowers respectively.

To understand the features of this model, the variables are stated in its general form as:

$$lny_{it} = \lambda lny_{i,t-1} + \lambda_2 lny_{i,t-2} + \emptyset_0 lnX_{it} + \emptyset_0 lnX_{i,t-1} + \emptyset_0 lnX_{i,t-2} + \varphi_t + V_{it};\ i = 1, N;\ t = 1, \ldots, T \ldots \quad (3.0)$$

$$v_{it} = u_{it} + w_{it} \quad (4.0)$$

Where: $y_{it}$is the response variable, x_{it} is the covariate variable, φ_t is the time fixed effects, $V_{it}$is the composite error, $u_{it}$is the specific error, and $w_{it}$is the common error. The specific error is time invariant but the common error varies across time and units.

4. Results

Before analysing the results, there is need to describe the data in order to show the movements and the distribution pattern of the underlying variables over time/across countries using graphs and statistics. The reason for using line graphs and descriptive statistics is to establish whether the variables are normally distributed or not. For this purpose, this study adopted the generalized methods of moments to bring the irregularly distributed panel data to the same unit of measurement. The first line graph shows the number of persons using ATM across the sample size and over the sample period. The second line and third line graphs shows the direction of the data used to measure financial inclusion by usage and quality over the period 2007–2017 and for all the 27 countries earlier mentioned.

The first line graph (Figure 2) displays the movements of digital finance (percentage of persons operating ATMs) overtime for each country. As shown in the graph, country 25 (Tanzania) has the highest number of persons operating ATMs, followed by country 23 (South Africa) and country 21 (Nigeria). The least countries that operate ATMs are 2, 5 and 7, which are Burundi, Cameroon and Congo Republic respectively.

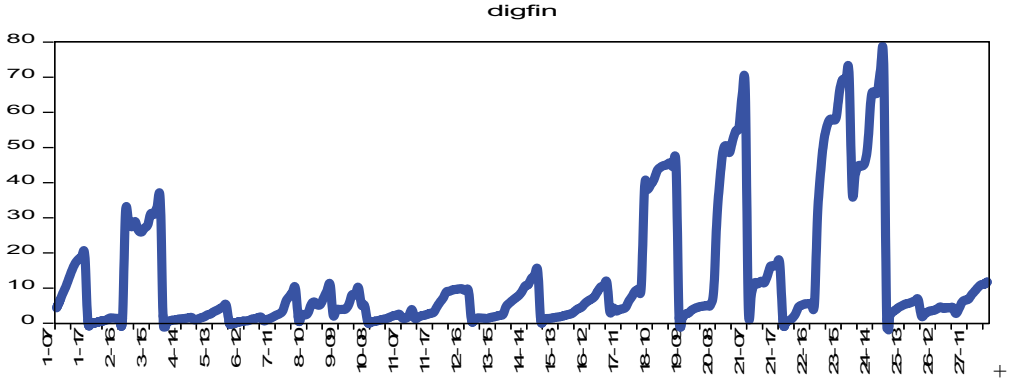

Figure 2. Line graph showing movements of digital finance in 27 SSA countries.

Source: Author's compiled.

The second line graph (Figure 3) shows the movements of financial inclusion by usage (deposit in commercial banks per 100 adults). It is observed in the graph that countries 13, 18, 19, 20, 24 and 25 (respectively Liberia, Mauritius, Malawi, Namibia, Seychelles and Tanzania) have the highest number of persons using the services of banks for depositing purpose. The study also observed that countries like Burundi, Central African Republic, Cameroon, Congo Democratic Republic and Congo Republic (2, 4, 5, 6 and 7) have the lowest usage. Meaning that they have very low magnitude of inclusion in term of usage.

The third graph presents the movements of financial inclusion by quality of services (ratio of depositors to borrowers). It is conventionally agreed that high quality of bank service would generate sufficient deposits to satisfy the needs of borrowers. A high ratio mobilizes much from the surplus unit to deficit unit, and it is an indication of high quality of financial inclusion. The

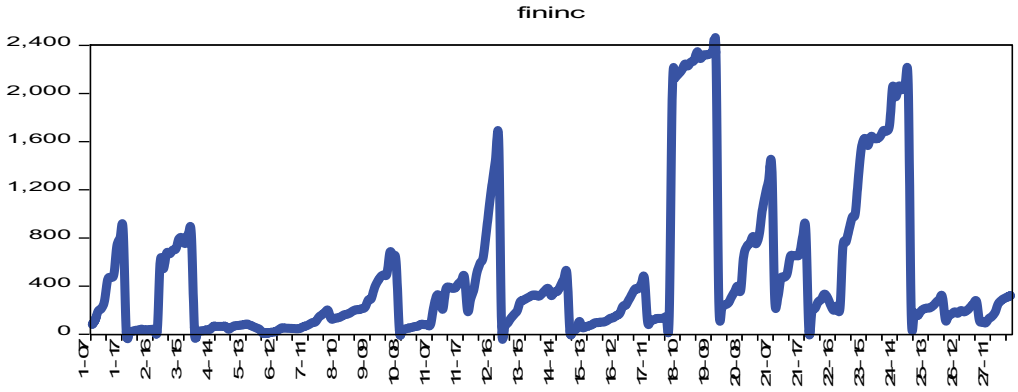

Figure 3. Line graph showing direction of financial inclusion by usage in 27 SSA countries.

Source: Author's compiled.

countries with the highest ratios are 2, 14, 21 and 22 (Burundi, Lesotho, Nigeria and Rwanda), while those with the lowest ratios are 1, 3, 4, 5, 17, 23 and 27 (Angola, Botswana, Central African Republic, Mauritania, South Africa and Zambia respectively). Therefore, Angola and Rwanda have the lowest financial inclusion in terms of quality.

Another means of describing data is to compute some statistics such as mean, standard deviation, skewness, kurtosis and Jarque-Bera (JB). The JB statistic is calculated with probability to test the null hypothesis of normality. Table 1 presents the outputs of these statistics.

The mean value of each of the variables is positive. Financial inclusion by usage, financial inclusion by quality and digital finance have the mean values of 4.83, 8.25 and 12.65, respectively. This implies that all these variables have displayed increasing tendency throughout the sampling period. The average inclusion by usage is approximately five depositors for every 1000 adults. This average value is small when considering the number of banks/branches in this region. Furthermore, average inclusion by quality is approximately 8. This indicates that borrowers are eight times more than depositors. Digital finance by the number of person operating ATMs has average of 13 person per 1000 adults. This simply means that average of 13 persons for every 1000 persons operate ATMs in the selected SSA. All the variables have larger value for their standard deviations more than their means. This is an indication that the variables are highly volatile around their mean values. The skewness scores for each of the variables is larger than zero and positive. By implication the variables are each positively skewed, meaning that there is tendency of large values in the nearest future. The kurtosis value for each variable is approximately larger than 3, thus, the variables are leptokurtic in nature with indication of possible outliers. All the computed JB statistics are asymptotic with 0% probability value. This means that each of the variables does not follow a Gaussian process confirming.

Table 1. Showing statistics from 2007 to 2017 in their raw values quantities

	FININC1	FININC2	DIGFIN
Mean	4.826391	8.246747	12.65485
Std. Dev.	6.019476	16.40644	17.77193
Skewness	1.866003	8.679656	1.876601
Kurtosis	5.496563	98.53028	5.416488
Jarque-Bera	249.4886	116,663.8	246.5836
Probability	0.000000	0.000000	0.000000
No of countries		27	
Year		10	
Observation		270	

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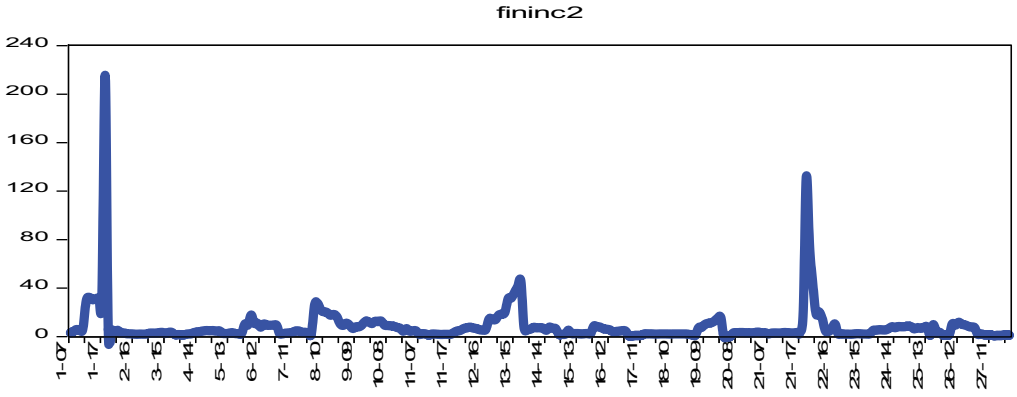


Figure 4. Line graph showing direction of financial inclusion by quality in 27 SSA countries.

Source: Author's compiled.

In this section, the parameters of the models stated in methods and materials are estimated using one-step Diff-GMM technique. This technique provides robust test for the hypotheses stated for this study. The hypotheses focus on the dynamics of inclusion and digital finance. Before reporting the results on the tests of these hypotheses, the study displays graphical reports on sample identification number, average individual country and average group financial inclusion by usage for the purpose of decomposing the countries into high usage (large saving countries) and low usage (small saving countries) to enhance the uniqueness of the results.

A sight view of Figure 5 above reveal that countries with identification numbers such as 2, 4, 5, 6, 7, 8, 10 and 15 have very low usage of financial services, followed by countries with id such as 1, 3, 9, 11, 12 etc. Nevertheless, countries like 18, 19, 20, 23 and 24 are large saving countries because they display high usage of financial services. (See Figure 4 above for the names of these countries.)

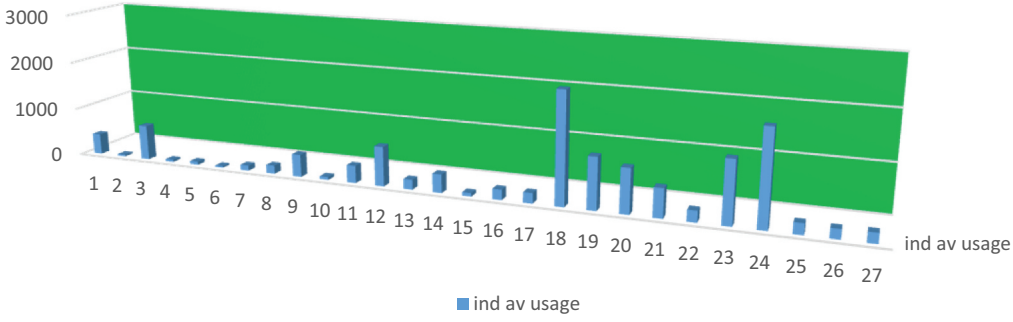
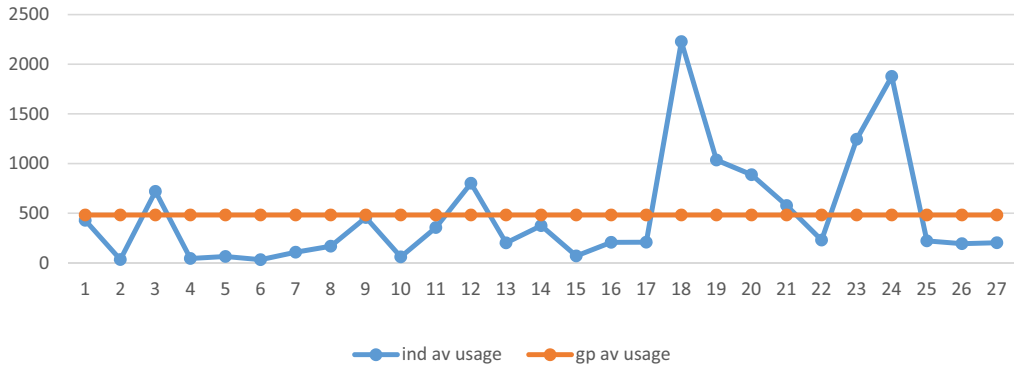


Figure 5. Shows graph of average usage of financial service by individual country's.

The line marked by blue colour indicates the movement of individual average usage, while the group average usage is marked by orange colour (Figure 6). The group average usage is constant (value = 482.64 approximately from the above graph) and any country that has average return above group average return is considered as large saving country or high usage of financial service; such countries are 3, 12, 18, 19, 20, 21, 23 and 24 (see Figure 4: sample identification number). While other countries whose individual average return falls below the group average are called low saving countries. In this case, countries nos. 1, 2, 4, 5, 6, 7, 8, 9, 10, etc. fall within this group. Thus, the test of the short run and long run dynamics of financial inclusion and digital finance is conducted for the low saving, high saving and the overall countries in the sample for the study (Table 2).

The ECM coefficient −0.30 has probability value of 0%. This is in consonant with a priori and it suggests that a long run relationship exists between financial inclusion and digital finance in SSA

Figure 6. Individual countries decomposed into high and low usage of financial services.



countries. Furthermore, the statistical significance of the ECM coefficient implies that if there is deviation from this long run equilibrium, short run adjustment in financial inclusion is necessitated to re-establish the long run relationship. Therefore, financial inclusion response to temporal shocks in digital finance. The coefficient of the short run effects −0.04 approximately associates with 9% probability value. This means that at 10% level of significance, short run dynamic influence runs from digital finance to financial inclusion in a manner that a percent increase in digital finance spelt about 4% decrease in financial inclusion in terms of usage. The long run coefficient by approximation is 0.20 or 30%, while the associated probability value 31% is asymptotically large. Thus, there is no significant response of financial inclusion to permanent shocks in digital finance for the overall sample of the selected SSA countries. It means that financial inclusion only responds/adjusts to temporal digital finance shocks, and not to its permanent shocks. For the sake of robustness check, these results are confirmed based on both large and small sub-sample of average usage. Sargan test and

Table 2. Long-run and short-run dynamics of financial inclusion and digital finance for the overall (group) sample

Regressors	Coefficient	Std. err.	Z-stat	*P* value
Δ lnfininc1 (−1)	−0.2955683	.099644	−2.97	0.003
Δ lndigfin1	−0.07827	.0664995	−1.18	0.239
Δlndigfin1 (−1)	0.0432098	.0665752	0.65	0.516
ECM	−0.3041471	.085378	−3.56	0.000
lndigfin1(−2)	−0.2442999	.0611352	−4.00	0.000
Summation of short-run coef.		−0.03506		
Short-run Wald test (*P* value)		0.0896		
Long run coefficient		0.196771		
Long run coef. (*P* value)		0.3110		
Sargan difference test (*P* value)		0.745		
Sargan test (*P* value)		0.727		
AR1 (*P* value)		0.00		
AR2 (*P* value)		0.84		
No of countries		27		
Year		10		
No. of observation		270		

Note: The dependent variable which financial inclusion is denoted by Δ(lnfininc1). The normality test is conducted by one-step Diff-GMM (Arellano, and Bond while the Sargan test is based on the assumption that the instruments are not correlated with the residuals. The AR1 and AR2 tests are based on the hypothesis that the errors are serially correlated whereas the instruments used are the lags of the regressors. The result excludes yearly dummies.

Sargan in Difference test produce probability values of 0.727 and 0.745 respectively. Meaning that the test results fail to reject the null hypothesis that the legitimate instruments does not correlate with the model residuals. The AR at lag 1 and lag 2 displays probability of 0.00 and 0.84 respectively; though the first-order autocorrelation is not rejected but the second-order autocorrelation is. Therefore, there is sufficient evidence in support of the appropriateness of the model specification.

The above table 3 shows the results on the dynamics of inclusive finance and digital finance for large saving countries among the selected SSA. As revealed in the table, the adjustment coefficient is found to be negative (−0.18 app.) and significant at 1%. This indicates that long run influence/causation runs from digital finance to financial inclusion, and when there is deviation in this influence, financial inclusion adjusts at the speed of 18% to every unit change/shock in digital finance within a short period (1 year here). In addition, the coefficient of the short run effects is approximately −0.46 (−46%), which is significant at 5%. This suggests that significant short run dynamic relationship exists between inclusion and digital finance in a manner that 1% increase in digital finance induces inclusion (by visiting bank) to reduce by 46%. This equally means that the presence of digital finance reduces the rate at which depositors visit bank for either receipts or payments on yearly basis. So also, the long run elasticity coefficient (0.48) is significant at 5%. This confirms the long run relationship earlier established by the ECM coefficient, and therefore, financial inclusion responses positively to permanent shocks in digital finance. Meaning that in the long run, any 1-unit change in digital finance will induce financial inclusion to change by 48% in the sample of large saving countries. The Sargan and Sargan in difference tests are not significantly dissimilar from zero, meaning that the instruments used are not weak. Likewise, the AR at lag 2 shows no autocorrelation in the residuals, thereby confirming the model to be adequate.

Table 3. Long-run and short-run dynamics of Financial inclusion and digital finance for large saving countries

Regressors	Coefficient	Std. err.	Z-stat	*P* value
Δ lnfininc1 (−1)	−.0418218	.115423	−0.36	0.717
Δ lndigfin1	−.9264673	.446969	−2.07	0.038
Δlndigfin1 (−1)	.4672208	.2266606	2.06	0.039
ECM	−.1782159	.0546977	−3.26	0.001
lndigfin1(−2)	−.0934051	.0465019	−2.01	0.045
Summation of short-run coef.		−0.4592465		
Short-run Wald test (*P* value)		0.0208		
Long run coefficient		0.475887954		
Long run coefficient (*P* value)		0.0278		
Sargan difference test (*P* value)		0.988		
Sargan test (*P* value)		0.995		
AR1 (*P* value)		-		
AR2 (*P* value)		0.690		
No. of countries		8		
Year		10		
No. of observation		80		

Note: The dependent variable which financial inclusion is denoted by Δ(lnfininc1). The normality test is conducted by one-step Diff-GMM (Arellano, and Bond while the Sargan test is based on the assumption that the instruments are not correlated with the residuals. The AR1 and AR2 tests are based on the hypothesis that the errors are serially correlated whereas the instruments used are the lags of the regressors. The result excludes yearly dummies.

The results in above table 4 are based on small saving countries, The ECM coefficient (−0.32) has a probability value of 0.00. Therefore, at alpha value of 1%, a long run dynamic relationship exists between inclusive finance and financial technology in the sample of low saving nations among the SSA. Besides, 32% disequilibrium in the long run is corrected within a short period (1 year). However, the coefficient of the long run elasticities is positive (0.11 app.) but not significant even at 10% alpha value. This infers that unlike large saving countries where financial inclusion responses to permanent shocks in digital finance, in small saving countries inclusion does not response to permanent shocks in digital finance. To the contrary, in small saving countries, financial inclusion adjusts faster to temporal shocks in digital finance than in large saving countries. The short run effects are negative in both small and large saving countries, though not significant in small saving countries. Thus, within the purview of short run, financial inclusion does not significantly decrease with any increase in digital finance for the small saving countries. For the post estimation tests, while the Sargan test reject the null hypothesis, Sargan in difference test fail to reject it. Likewise, the AR(1) is in support of autocorrelation, while the AR(2) rejects it. This means that there is no strong evidence in support of the adequacy of the model for small saving countries. The GMM is achieved by differencing the variables by one step as depicted in the above tables. For instance, for the difference for financial inclusion and digital finance is denoted by Δ lnfininc1 (−1) and Δlndigfin1 (−1) respectively.

Table 4. Long-run and short-run dynamics of FI and digital finance for small saving countries

Regressors	Coefficient	Std. Err.	Z-stat	*P* value
Δ lnfininc1 (−1)	−.369746	.0968988	−3.82	0.000
Δ lndigfin1	−.0671738	.0562784	−1.19	0.233
Δlndigfin1 (−1)	.0050556	.0607665	0.08	0.934
ECM	−.3227168	.0889531	−3.63	0.000
lndigfin1(−2)	−.2885243	.060493	−4.77	0.000
Summation of short-run coef.		−0.0621182		
Short run Wald test (*P* value)		0.2818		
Long run coefficient		0.10595203		
Long run coefficient (*P* value)		0.5366		
Sargan difference test (*P* value)		0.111		
Sargan test (*P* value)		0.040		
AR1 (*P* value)		0.000		
AR2 (*P* value)		0.729		
No. of observations		190		
No. of countries		19		

Note: The dependent variable which financial inclusion is denoted by Δ(lnfininc1). The normality test is conducted by one step Diff-GMM (Arellano, and Bond while the Sargan test is based on the assumption that the instruments are not correlated with the residuals. The AR1 and AR2 tests are based on the hypothesis that the errors are serially correlated whereas the instruments used are the lags of the regressors. The result excludes yearly dummies.

5. Discussion

The Sustainable Development Goals examined in this study includes employment/job creation (goal 8), poverty reduction (goal 1) and hunger elimination (goal 2). The a priori expectation is that when financial inclusion is driven on digital financial platforms those in rural communities who originally could not be included into formal financial net will be captured using financial technology. The result shows evidence of a long run relationship between digital finance and financial inclusion for both large and small saving countries. With an ECM coefficient of less than zero for the overall, large and small sample sizes shows that there is long run multiplier effects between digital finance and inclusive finance for all the three sets of countries. This altogether means that in the short run dynamics, any unit increase in digital finance

induces a decline in financial inclusion, but in the long run, digital finance appears to have a positive determinant of financial inclusion for the selected SSA countries. This result agrees with the findings of Demombynes and Thegeya (2012), Honohan and King (2012), Jack and Suri (2014), Ozili (2018), Vo and McAleer (2019) which posit that digital financial inclusiveness has the capacity to reduce every barriers towards accessing cheap finance that will enable the poor create wealth, reduce poverty and inequality gap as well as provide employment for themselves and others. Likewise the International Finance Cooperation report for 2017 posit that through an array of digital finance services and products, large number of low income persons and micro-enterprises in rural communities have been included into mainstream finance culminating into job creation and poverty reduction (IFC, 2017). Also Dabla-Norris et al. (2015) posit that financial inclusion is a necessary condition to address inequality issues in emerging and developed economies and for developed countries, policies should be channelled towards developing human capitals and skill acquisition as well installing a progressive tax system.

The implication is that increase in digital financial inclusion will reduce the frequency at which person visit the banks for simple financial transactions culminating to more persons being captured into mainstream finance for the strands of small, large and overall savings countries but the changes will be more pronounced with the small saving countries. As more people embrace mainstream finance through digital technology, the gaps between the poor and rich will gradually begin to close because they are able to access needed credit to create wealth for themselves and their families thereby lifting themselves from extreme poverty. If the poor are empowered through the use of digital finance, they will be able to create jobs for themselves and also employ others thereby fulfilling the Sustainable Development Goals of hunger elimination, inequality reduction and employment generation and of course poverty reduction.

6. Conclusion and recommendations

The Sustainable Development Goals examined in this study includes employment/job creation, poverty reduction and hunger elimination. The a priori expectation is that when financial inclusion is driven on digital financial platforms those in rural communities who originally could not be included into formal financial net will be captured using financial technology. In view of the findings summarized above and based on the hypothesis of the research we conclude that the effect of digital finance on inclusive finance react differently over the short run and long run go-ahead. In the short run, digital financial technology influences financial enclosure negatively, however, in the long run digital finance exerts positive influence on financial enclosure. Therefore, the research further concludes that in the long run, digital finance drives financial inclusion positively. The implication is that the more persons are captured via inclusive digital finance, the more credit will be made accessible to them based on the history of the account and the more wealth is created thereby leading to poverty and inequality reduction. It therefore recommends that Banks should encourage customers to be withdrawing, transferring and depositing money through ATMs. The orthodox method of paying and receiving money through counters should be discouraged. This will increase the usage of financial technology to definitely motivate financial enclosure. To ensure maximum use of ATM cards and other debits cards, the central banks of respective countries should introduce a policy that disallow certain amount of money not to be posted or received through the counter. Furthermore, they can impose penalties for over the counter transactions in banking halls as currently witnessed in Nigeria for example.

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